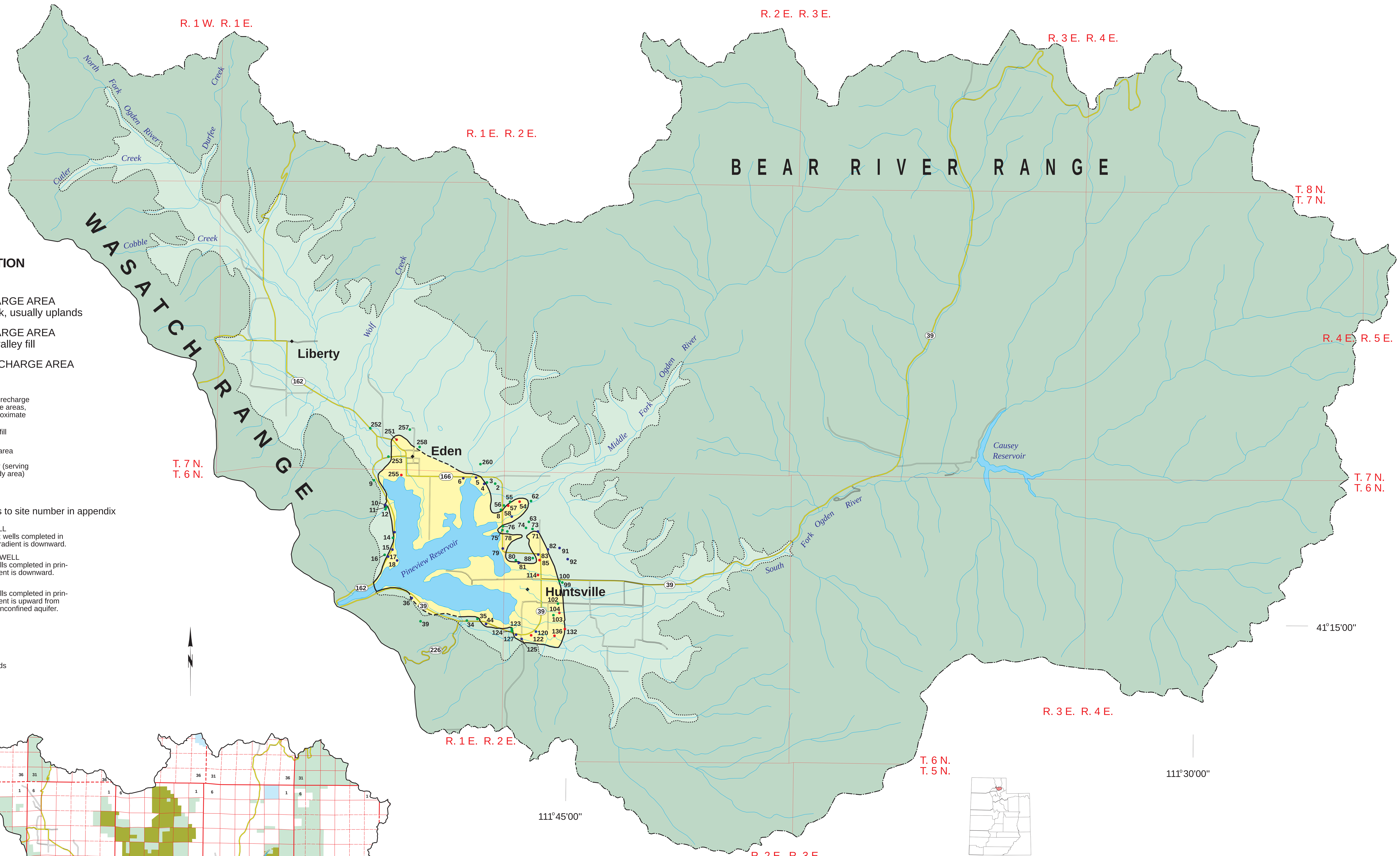
Utah Geological Survey Map 176
Recharge Areas of the Ogden Valley

MAP OF RECHARGE AREAS FOR THE PRINCIPAL VALLEY-FILL AQUIFER, OGDEN VALLEY, WEBER COUNTY, UTAH

by Noah P. Snyder and Mike Lowe

Digital compilation by Janine L. Jarva

1998



EXPLANATION

- PRIMARY RECHARGE AREA
  Consolidated rock, usually uplands
- PRIMARY RECHARGE AREA
  Unconsolidated valley fill
- SECONDARY RECHARGE AREA

Boundary between recharge areas and discharge areas, dashed where approximate

Boundary of valley fill

Boundary of study area

Boundary of county (serving as boundary of study area)

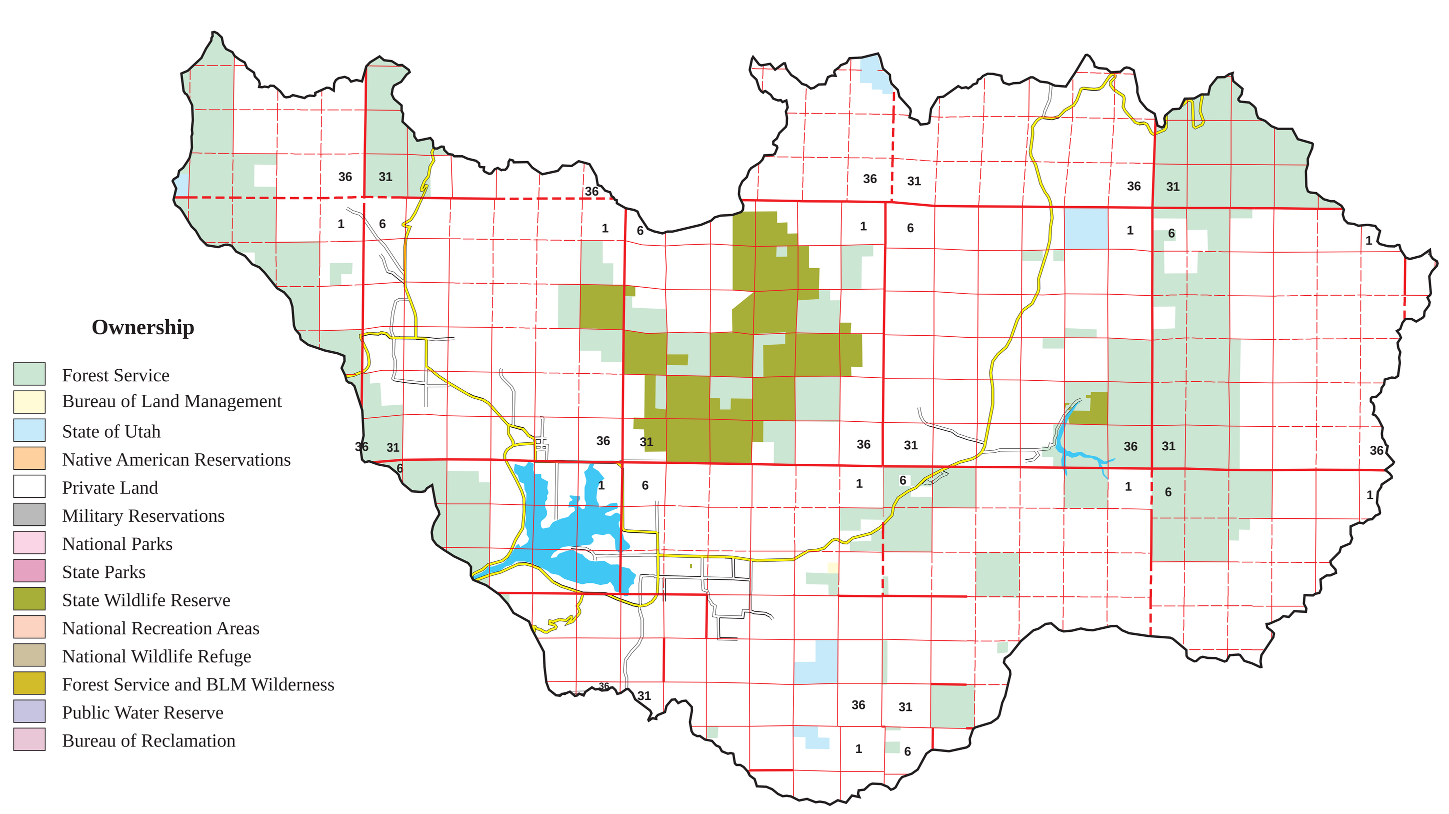
WELLS Number refers to site number in appendix

- PRIMARY RECHARGE WELL
  Confining layers not present; wells completed in principal aquifer; hydraulic gradient is downward.
- SECONDARY RECHARGE WELL
  Confining layers present; wells completed in principal aquifer; hydraulic gradient is downward.
- DISCHARGE WELL
  Confining layers present; wells completed in principal aquifer; hydraulic gradient is upward from principal aquifer to shallow unconfined aquifer.

US Highways

State Highways

County & City Roads



ADMINISTRATIVE OWNERSHIP INSET MAP

Digital Data from the State Geographic Information Database (SGID)

1 0 1 2 3 4 5 6 MILES

5,000 0 5,000 10,000 15,000 20,000 25,000 30,000 FEET

1 0 1 2 3 4 5 6 7 8 9 KILOMETERS

LOCATION MAP

This map was partially funded by the U.S. Environmental Protection Agency under the Clean Water Act, Section 319, nonpoint source program, and by the Utah Department of Environmental Quality, Division of Water Quality.

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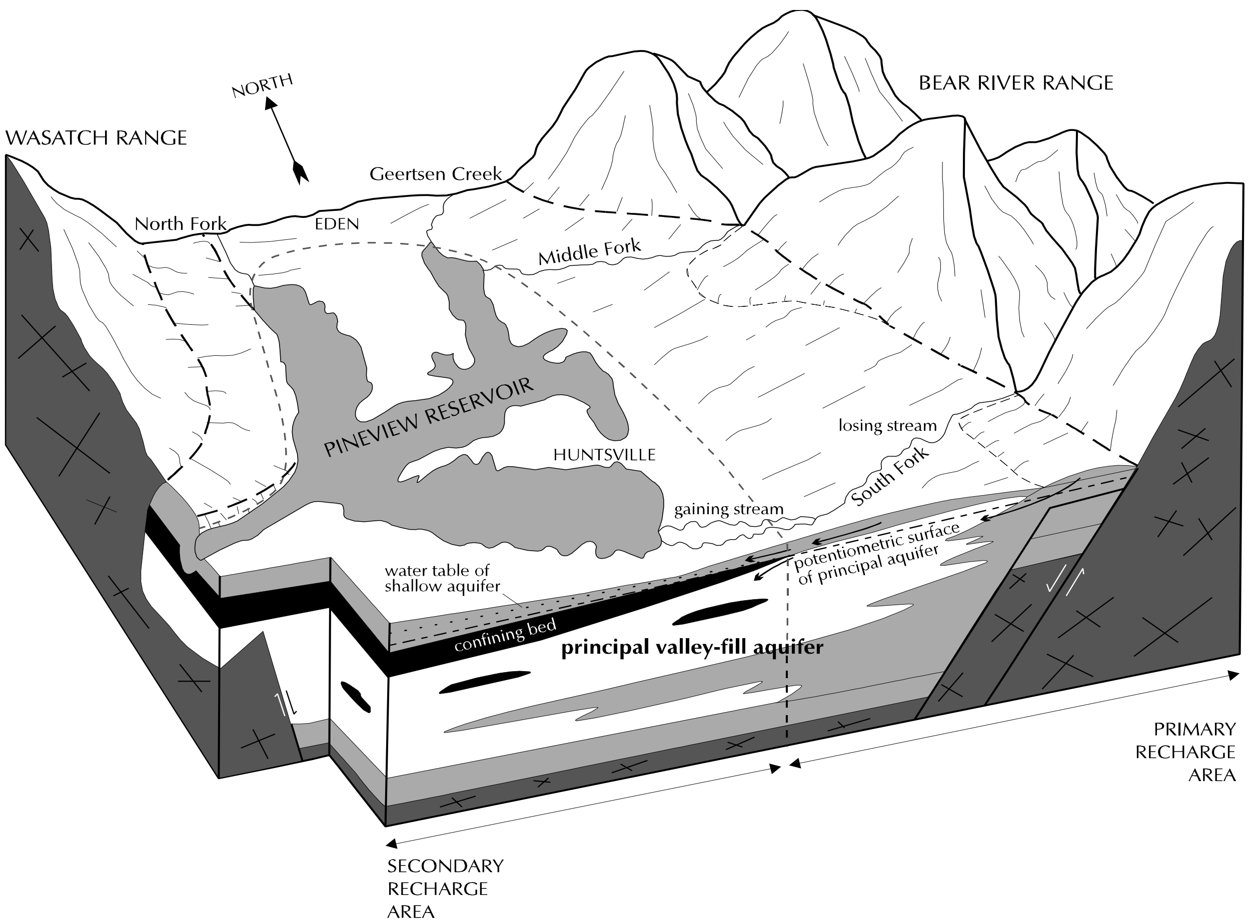

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MAP OF RECHARGE AREAS FOR THE PRINCIPAL VALLEY-FILL AQUIFER, OGDEN VALLEY, WEBER COUNTY, UTAH

by Noah P. Snyder and Mike Lowe

ABSTRACT

Wells in Ogden Valley provide drinking water for residents of the valley and Ogden City. Ground-water conditions in Ogden Valley have been studied for the past 60 years because of the importance of the resource to the Wasatch Front. Residential and recreational development has increased in Ogden Valley, underscoring the importance of maintaining a high-quality ground-water supply. In this study we mapped recharge areas for the principal valley-fill aquifer to aid in management of potential contaminant sources to protect the quality of ground water.

Ogden Valley is 6 miles (9.7 km) east of Ogden City, between the Wasatch and Bear River Ranges. The principal valley-fill aquifer is in the center of Ogden Valley beneath Pineview Reservoir. It consists of alluvial and lacustrine gravel, and is partly overlain by a thick lacustrine silt confining bed. The aquifer extends beyond the confining bed and, in the northern and eastern parts of the valley, consists of alluvial-fan and fluvial sediments under water-table conditions. Ground-water flow is from the mountains toward Pineview Reservoir, with most recharge coming from seepage of surface water during spring snowmelt. The mountains surrounding the valley and the periphery of the valley floor beyond the confining layer are the primary recharge area. The land above the confining layer is the secondary recharge area. Discharge is by evapotranspiration, wells, and seepage to surface water. There is no mapped discharge area, because discharging wells, primarily located near Pineview Reservoir, are too localized and variable (depending on reservoir level). At present, ground-water quality is excellent, although the possibility for contamination is significant, particularly with increased residential development in primary recharge areas.

INTRODUCTION

Background

Wells in the confined aquifer in Ogden Valley supply much of the municipal water for the residents of the valley and Ogden City. The valley has undergone rapid residential and recreational development during the past 20 years, and we anticipate that this trend will only continue. The growing population will need additional ground water and increase the potential for water-quality degradation.

The primary source of ground water in Ogden Valley is infiltration of precipitation and surface water from the hills and mountains surrounding the valley. Ground-water recharge areas are typically underlain by fractured rock or coarse-grained sediment having relatively little ability to inhibit infiltration or renovate contaminated water. Ground-water flow in recharge areas has a downward component and relatively fast rate of movement. Because contaminants can readily enter an aquifer system in recharge areas, the siting and management of potential contaminant sources in these areas deserve special attention to protect ground-water quality. Ground-water recharge-area mapping defines these vulnerable areas.

Ground-water recharge-area maps typically show: (1) primary recharge areas, (2) secondary recharge areas, and (3) discharge areas (Anderson and others, 1994). Primary recharge areas, commonly the uplands and coarse-grained unconsolidated deposits along valley margins, do not contain thick, continuous, fine-grained layers and have a downward ground-water gradient. Secondary recharge areas, commonly valley benches, have fine-grained layers thicker than 20 feet (6 m) and downward ground-water gradients.

Ground-water discharge areas are generally in valley lowlands. Discharge areas for unconfined aquifers are where the water table intersects the ground surface forming springs or seeps. Discharge areas for confined aquifers are where the ground-water gradient is upward and water is discharging to a shallow unconfined aquifer above the upper confining bed, or to a spring. Water from wells which penetrate confined aquifers may flow to the surface naturally. The extent of both recharge and discharge areas may vary seasonally and from dry years to wet years.

Purpose and Scope

The purpose of this study is to help state and local government officials and local residents protect the quality of ground water in Ogden Valley by defining areas where ground-water aquifers are vulnerable to contamination. The study is a cooperative effort among the Utah Geological Survey (UGS), the Utah Division of Water Quality (DWQ), and the U.S. Environmental Protection Agency (EPA).

The scope of work included a search for well-log data, a literature review, and field reconnaissance to define geologic and hydrologic conditions in Ogden Valley. We collected logs for water wells drilled in the valley prior to June 1995 from the State Engineer's office. We entered well-log information into a database and plotted well locations on 1:24,000-scale base maps. Generalized recharge- and discharge-area boundaries were then drawn and digitized, along with selected well locations, into the State Geographic Information Database.

Setting

The 310 square-mile (800 km^2) Ogden Valley drainage basin forms the eastern half of Weber County (figure 1). It is an intermontane valley of high elevation and relief in the Wasatch Hinterland section of the Middle Rocky Mountains physiographic province (Stokes, 1977). Ogden Valley is a popular recreation area located 6 miles (9.7 km) east of Ogden City on the eastern side of the Wasatch Range in northern Utah.

Physiography and Drainage

Ogden Valley is bordered by the Wasatch Range on the west and the Bear River Range on the east. Elevations along the Wasatch ridgeline reach close to 10,000 feet (3,000 m) at the summits of Ben Lomond and Willard Peaks. The Bear River Range is generally lower and not as steep. The valley floor has an average elevation of 4,900 feet (1500 m) and slopes gently to the west. The watershed is drained by the North, Middle, and South Forks of the Ogden River. The forks converge at Pineview Reservoir, which is drained by the main stem of the Ogden River through Ogden Canyon. The Pineview Reservoir dam was built in 1936, and was raised to its present crest elevation of 4,889 feet (1,490 m) in 1957. The reservoir provides irrigation and municipal water for Ogden City and other communities along the Wasatch Front.

Climate

The Pineview Reservoir dam receives an average of 30.85 inches (78.4 cm) of precipitation per year, whereas Huntsville four miles to the east averages 21.44 inches (54.4 cm) (Ashcroft and others, 1992). This difference is due to the orographic effect of Ogden Canyon and the Wasatch Range (Avery, 1994). Seventy-five percent of the annual precipitation in Ogden Valley falls between October and April, generally as snow (Avery, 1994). The annual melt normally occurs during April and May. Mean annual temperature in Ogden Valley is 44°F (7°C); the climate is typified by cold winters and mild summers (Ashcroft and others, 1992).

Land Use

The population of Ogden Valley was 5,644 in 1993 (Wasatch Front Regional Council, written communication, 1995). The valley has been undergoing a change from cropland to rural subdivisions, a trend that may accelerate in the future. Recent completion of Trappers Loop Road connecting Ogden Valley to Morgan Valley and Interstate 84 has improved access, resulting in pressure to change zoning from five-acre to one-acre lots. The valley is a very popular year-

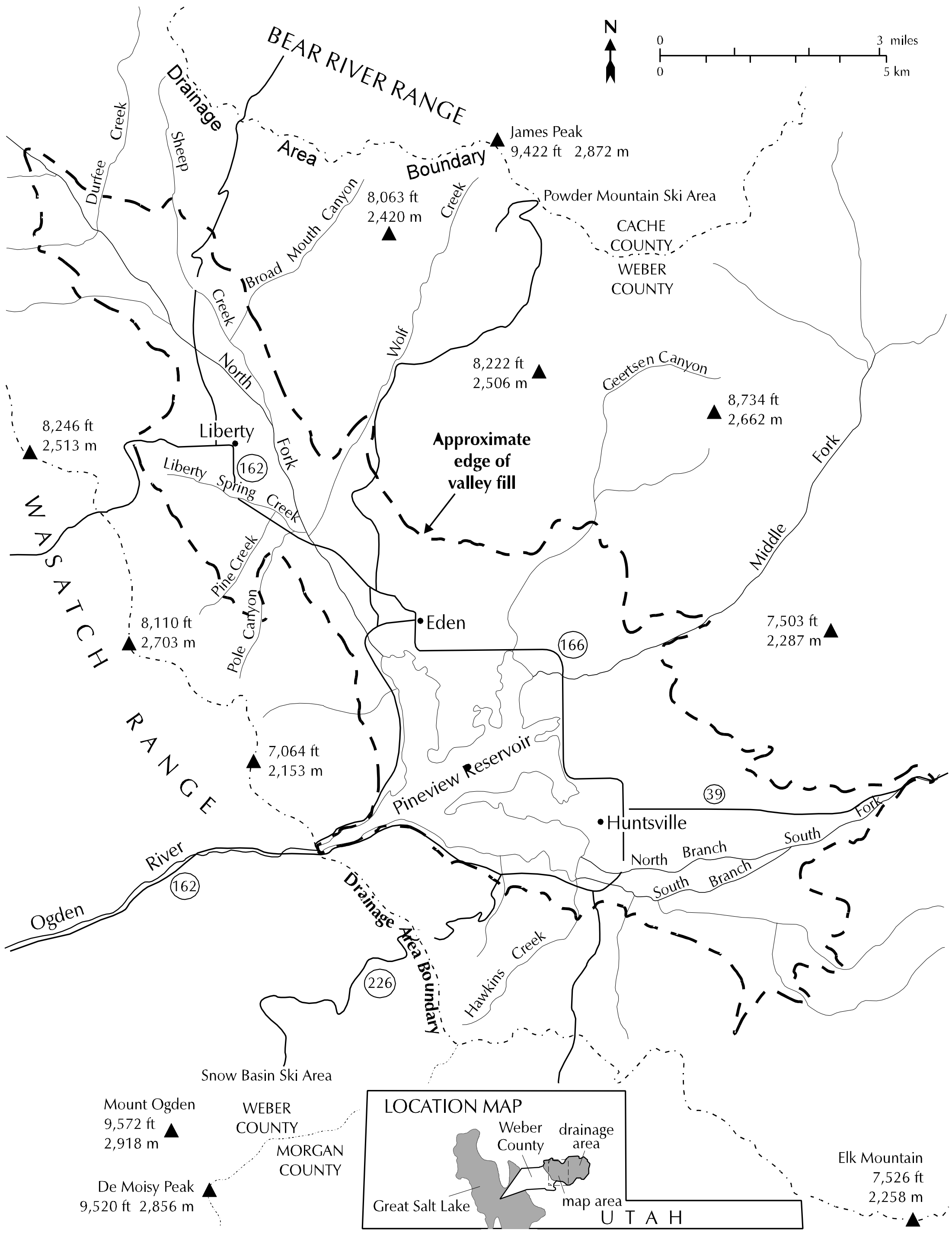

Figure 1. Ogden Valley study area.

round recreation area with three ski resorts including Snow Basin, the site of several 2002 Winter Olympic events. Pineview Reservoir is commonly used for boating and swimming. The trails and campgrounds of the Cache National Forest also receive many visitors.

Previous Studies

Previous hydrogeologic investigations in Ogden Valley include Leggette and Taylor (1937), Lofgren (1955), Doyuran (1972), and Avery (1994). Lowe and Miner (1990) investigated water quality and septic-tank suitability. Lofgren (1955) produced a generalized geologic map and discussed the Tertiary and Quaternary stratigraphy of Ogden Valley. Geologic mapping by the U.S. Geological Survey in Ogden Valley includes Crittenden (1972), Sorensen and Crittenden (1979), and Crittenden and Sorensen (1985a,b). Lowe (Utah Geological Survey unpublished map) has completed a Quaternary geologic map for Ogden Valley.

METHODS

The methods used in this study for identifying confining layers, classifying aquifers, and delineating recharge and discharge areas are modified from those of Anderson and others (1994). This study is concerned with the principal aquifer and a local overlying shallow unconfined aquifer (figure 2). The principal aquifer is the most important source of ground water, and may be confined or unconfined. The principal aquifer begins at the mountain front on either side of the valley where coarse-grained alluvial-fan sediments predominate and ground water is generally unconfined. Near the head of Ogden Canyon, fine-grained silt and clay strata form confining layers above and within the principal aquifer. If water is present in sediments above the top confining layer, a shallow unconfined aquifer is present. This is generally not a source of drinking water.

We used drillers' logs of water wells to delineate primary and secondary recharge areas based on the presence of confining layers and relative water levels in the principal and shallow unconfined aquifers. We compiled a database of well-log information (appendix). The use of drillers' logs requires interpretation because of the variable quality of the logs. Correlation of geology from well logs is difficult because lithologic descriptions are generalized and commonly inconsistent among various drillers. The use of water-level data from well logs is also problematic because levels in the shallow unconfined aquifer are often not recorded and because water levels were measured during different seasons and years.

Confining layers are any fine-grained (clay and/or silt) layer thicker than 20 feet (6 m) (Anderson and others, 1994). Sometimes a driller will note both clay or silt and sand along the same interval on logs, without giving relative percentages; these units are not classified as confining layers (Anderson and others, 1994). If both are checked and the word "sandy" is written in the remarks column, then the layer is assumed to be primarily a clay confining layer (Anderson and others, 1994).

The primary recharge area for the principal aquifer is the uplands surrounding the valley, and valley fill not containing confining layers, generally along valley margins (figure 3). Ground-water flow in the primary recharge area has a downward component. If present, secondary recharge areas are where there are confining layers, but ground-water flow still has a downward component. Secondary recharge areas generally extend toward the valley lowlands to the point where the ground-water-flow gradient becomes upward (figure 3). The ground-water-flow gradient, also called the hydraulic gradient, is upward when the potentiometric surface of the principal aquifer is higher than the water table in the shallow unconfined aquifer (Anderson and others, 1994). Water-level data for the shallow unconfined aquifer are not common, but can be found on some well logs. When the confining layer extends to the ground surface, the secondary recharge area is where the potentiometric surface in the principal aquifer is below the ground surface.

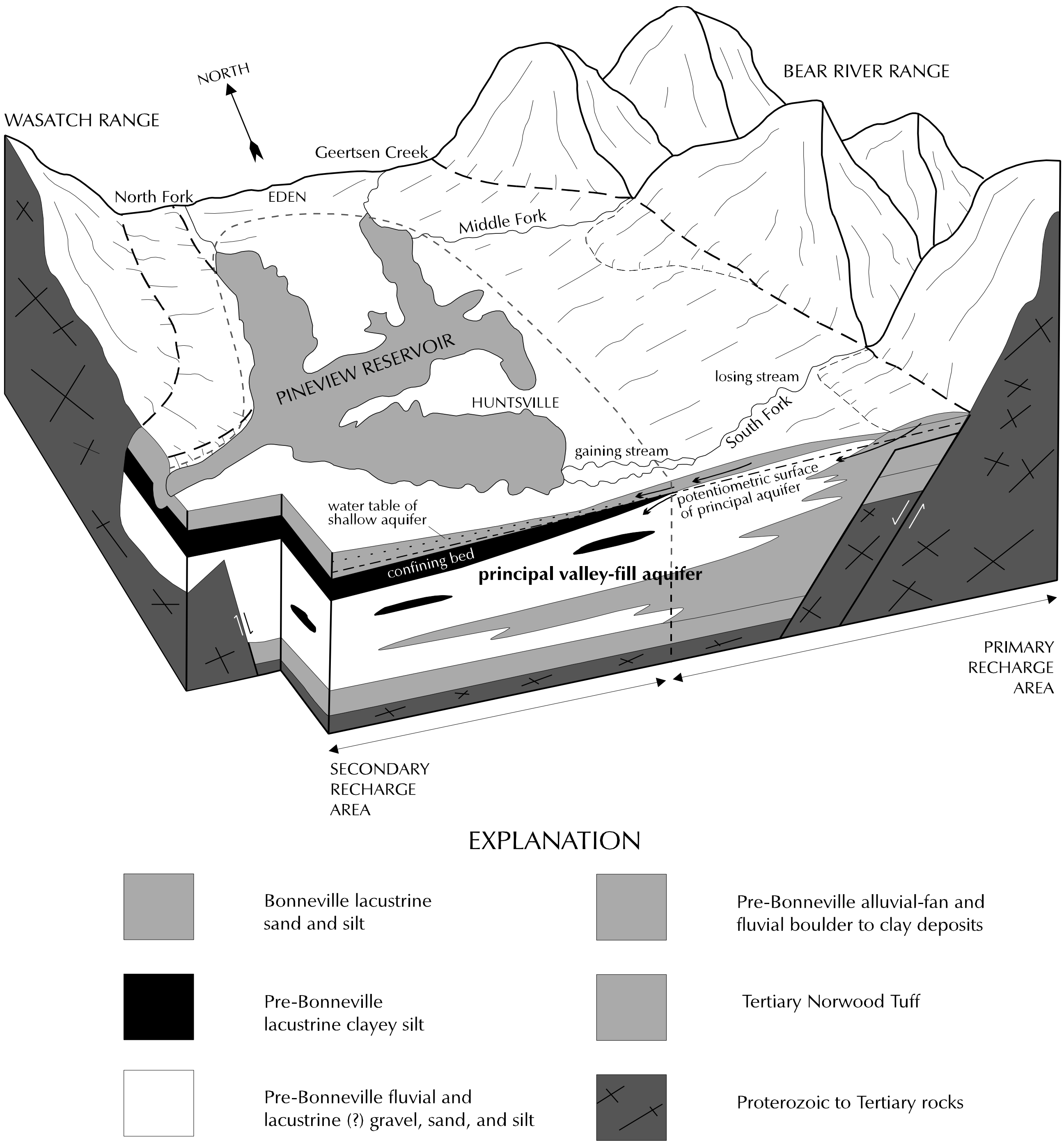

Figure 2. Schematic block diagram showing direction of ground-water flow and subsurface geology in Ogden Valley (modified from Lowe and Miner, 1990).

Ground-water-discharge areas, if present, are generally at lower elevations than recharge areas. In discharge areas, the water in confined aquifers discharges to the land surface or to a shallow unconfined aquifer (figure 3). For this to happen, the hydraulic head in the principal aquifer must be higher than the water table in the shallow unconfined aquifer. Otherwise, the downward pressure from the shallow aquifer will exceed the upward pressure from the confined aquifer, creating a net downward gradient indicative of secondary recharge areas. Flowing (artesian) wells, indicative of recharge areas, are marked on drillers' logs and sometimes on U.S. Geological Survey 7.5' quadrangle maps. Wells having potentiometric surfaces above the top of the confining layer can be identified from well logs. Surface water, springs, or phreatophytic plants (wetlands) can be another indicator of ground-water discharge. In some instances, however, this discharge may be from a shallow unconfined aquifer. It is necessary to understand the topography, surficial geology, and ground-water hydrology before using wetlands to indicate discharge from the principal aquifer.

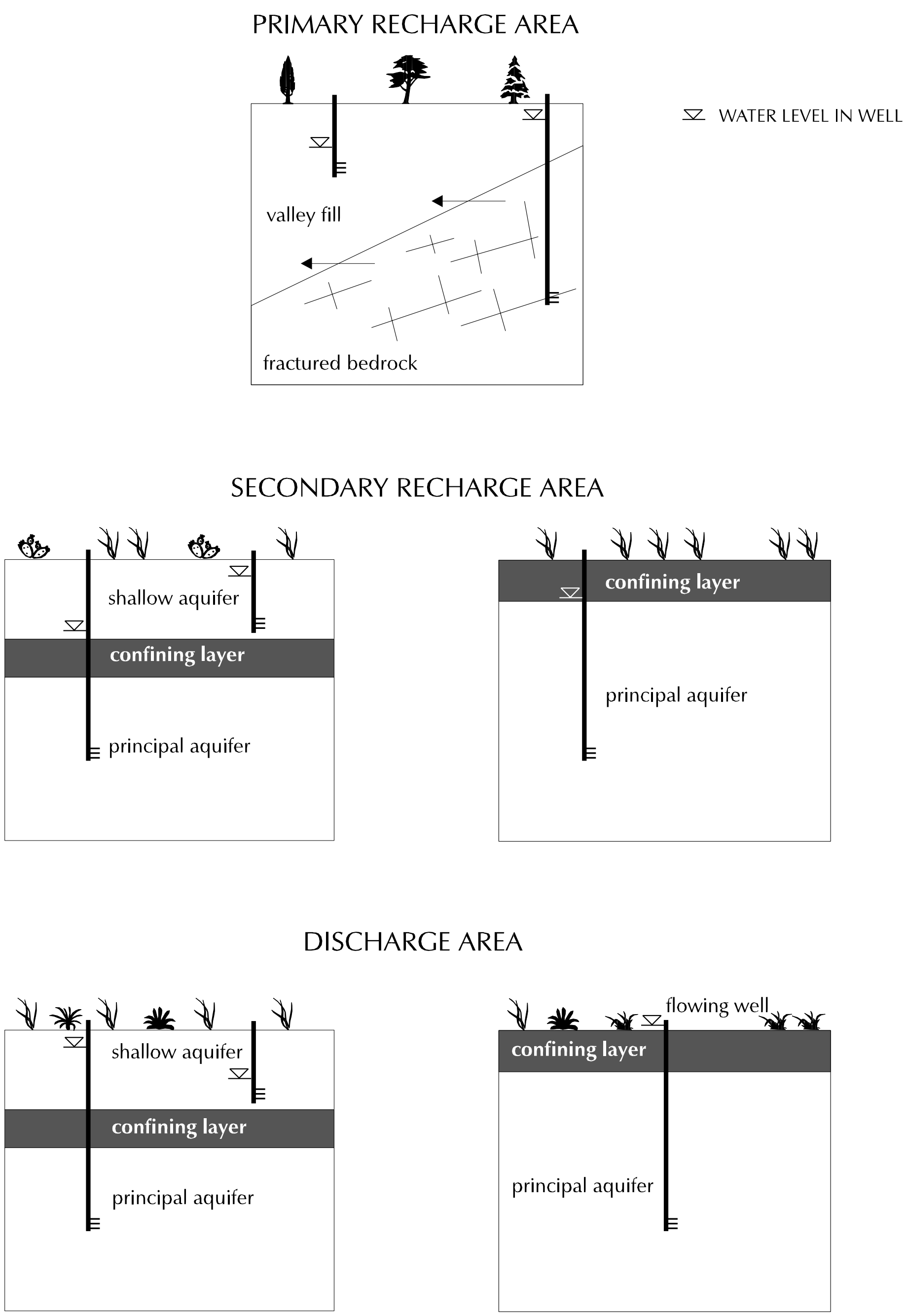

Figure 3. Relative water levels in wells in recharge and discharge areas.

We generally did not map small secondary recharge areas (defined by local confining layers in only a few wells) where surrounded completely by primary recharge areas, because contaminants entering the aquifer system above these clay layers of local extent still have a high potential to reach primary recharge areas.

The numbering system for wells in this study is based on the Federal Government cadastral land-survey system that divides Utah into four quadrants (A-D) separated by the Salt Lake Base Line and Meridian (figure 4). The study area is entirely within the northeastern quadrant (A). The wells are numbered with this quadrant letter D, followed by township and range, enclosed in parentheses. The next set of characters indicates the section, quarter section, quarter-quarter section, and quarter-quarter-quarter section, designated by the letters a through d, indicating the northeastern, northwestern, southwestern, and southeastern quadrants, respectively. A number after the hyphen corresponds to an individual well within a quarter-quarter-quarter section. For example, the well (D-6-2)9adb-1 would be the first well in the northwestern quarter of the southeastern quarter of the northeastern quarter of section 9, Township 6 North, Range 2 East (NW¼SE¼NE¼ section 9, T. 6 N., R. 2. E.).

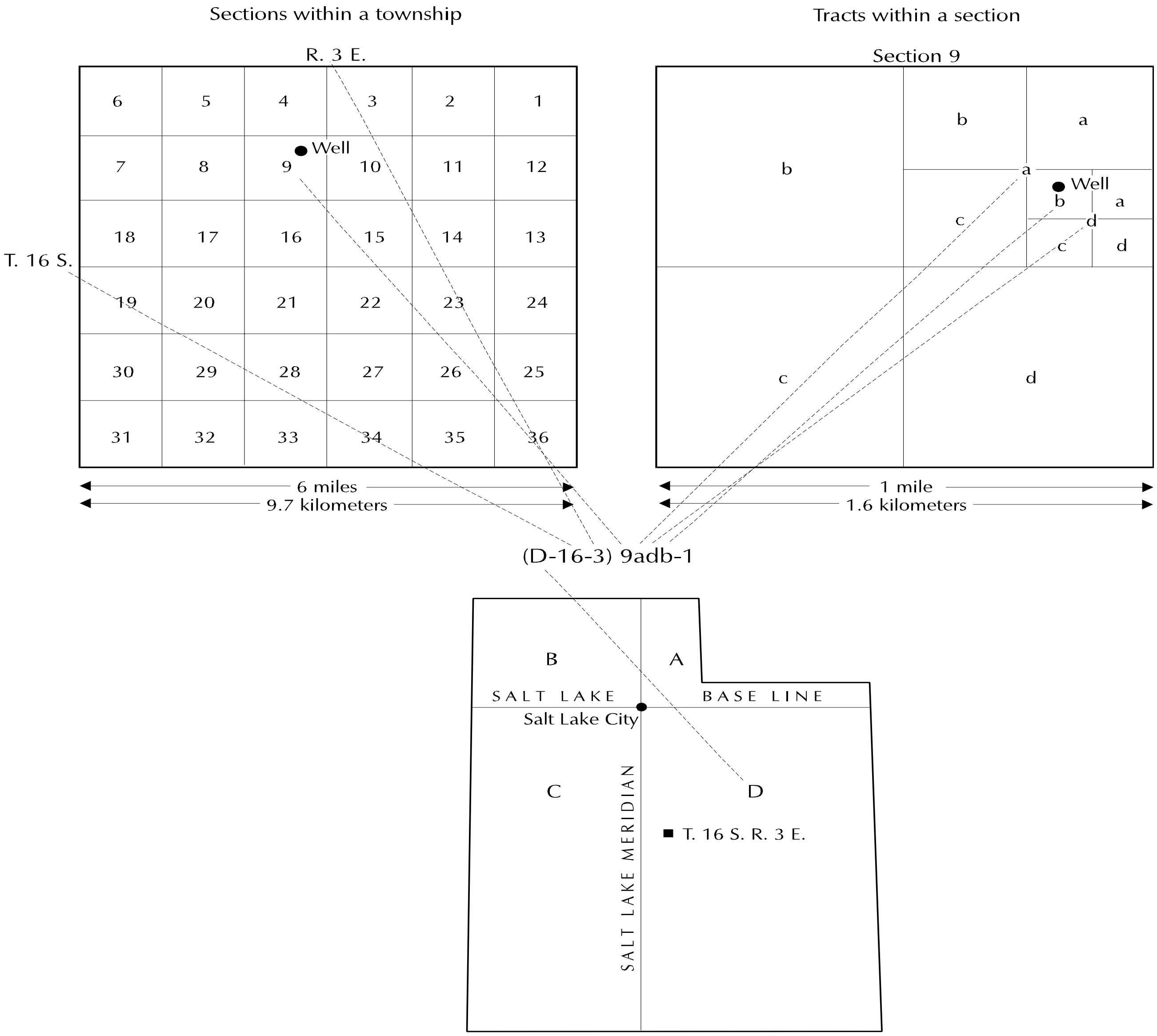

Figure 4. Numbering system for wells in Utah (see text for additional explanation).

GEOLOGY

Bedrock

Ogden Valley is a graben bounded to the east and west by northwest-trending normal faults that dip toward the center of the valley. The Wasatch Range to the west is an accompanying horst. Both formed during Basin and Range faulting in the past 15 million years (Hintze, 1988). In the Wasatch and Bear River Ranges, the Willard Thrust pushed Precambrian metasedimentary rocks over Paleozoic carbonates during the Sevier orogeny in late Cretaceous to early Tertiary time (Yonkee and others, 1992). These rocks make up the mountains that surround Ogden Valley to the west, north, and east. To the east, in the Bear River Range, these Paleozoic and Precambrian rocks are capped by gently dipping Cretaceous to Tertiary conglomerates of the Wasatch and Evanston Formations. The low, rounded hills that form the southern divide between Ogden and Morgan Valleys consist of the Tertiary pyroclastic Norwood Tuff. This fine-grained, impermeable formation also crops out along the eastern and western margins of the valley and probably underlies the valley fill.

Unconsolidated Sediments

Ogden Valley is an elongate structural trough that has been accumulating sediments during the past 15 million years (Hintze, 1988). Unconsolidated deposits are approximately 750 feet (225 m) thick northeast of Huntsville, and 500 feet (150 m) thick in the vicinity of Liberty (Avery, 1994). The sediments are alluvial, fluvial, and lacustrine in origin. The unconsolidated sediments most crucial to this study are the pre-Lake Bonneville lacustrine silt confining beds and the underlying pre-Lake Bonneville gravel deposits (Lofgren, 1955). These gravel deposits form the principal aquifer in the valley and are the source for much of the drinking water for Ogden City.

The basal valley-fill unit of hydrogeologic significance consists of the aquifer-forming pre-Lake Bonneville fluvial and alluvial-fan deposits; 80 percent of the artesian wells in Ogden Valley are completed in these deposits (Lofgren, 1955). This unit is predominantly gravel, containing layers of sand and silt and lenses of fine-grained, horizontally bedded, pre-Lake Bonneville lacustrine deposits.

The principal valley-fill aquifer is partly confined by lacustrine silt. This low-permeability unit is as much as 100 feet (30 m) thick under the western part of Pineview Reservoir, but thins and does not exist north of Eden and east of Huntsville. The unit is made up of thin, horizontal, uniform layers of dark, dense micaceous silt, believed to be derived from the Precambrian phyllite and argillite of the North Fork drainage (Lofgren, 1955). The unit was deposited offshore in a lake, possibly during the Little Valley lake cycle (Lowe and Miner, 1990) sometime between about 160,000 and 132,000 years ago (Machette and others, 1987). Reworking and erosion by streams has cut channels up to 25 feet (7.5 m) deep into the lacustrine silt.

Above the confining layer, well-sorted Bonneville lake-cycle silt and sand predominate, along with some poorly sorted post-Lake Bonneville alluvial-fan, floodplain, and slope-wash deposits (Doyuran, 1972). The Bonneville lake-cycle sediments are cyclically bedded sand, silt, and clay at some locations (Lofgren, 1955). Beyond the outer margins of the confining layer, alluvial-fan, floodplain, and colluvial deposits predominate, although Lake Bonneville shoreline deposits mantle the valley margins at some locations. In general, the fluvial, alluvial-fan, and colluvial deposits are coarse grained, but clay lenses are found within these deposits throughout the northern part of Ogden Valley. These coarse-grained deposits may be several hundred feet thick near the margin of the confining layer, but they thin toward the mountain fronts and thicken toward the head of Ogden Canyon.

GROUND WATER

Ground water is in both fractured bedrock and unconsolidated sediments in Ogden Valley. The majority of ground water in the study area is derived from precipitation and seepage from streams. An insignificant amount of water originating outside the drainage basin reaches the valley through bedrock fractures (Avery, 1994).

The quality of ground water in Ogden Valley is generally high. Drinking-water and ground-water protection regulations in Utah classify ground water, based largely on total-dissolved-solids concentrations, as follows: class IA (pristine), less than 500 mg/L; class II (drinking water quality), 500 to 3,000 mg/L; class III (limited use), 3,000 to 10,000 mg/L; and class IV (saline), more than 10,000 mg/L. Class IA and II waters are considered suitable for drinking, provided concentrations of individual contaminants do not exceed state and federal ground-water-quality standards. Water having total-dissolved-solids concentrations in the higher part of the class II range is generally suitable for drinking water only if treated, but can be used for some agricultural or industrial purposes without treatment. Most of the water in Ogden Valley is class IA and II.

Fractured-Rock Aquifers

Water is found in the consolidated rock beneath and surrounding Ogden Valley. Few wells are drilled into fractured-rock aquifers because the valley-fill aquifer in Ogden Valley is so productive and most of the current population, which depends on wells for its water supply, lives on the valley floor. However, recent development in Ogden Valley is reaching higher up the mountain slopes, increasing the need for bedrock wells. Fractured-rock aquifers provide some recharge to the valley-fill aquifers.

Aquifer Characteristics

Bedrock wells locally provide water for agricultural and culinary use. Fractured-rock aquifers are generally under water-table conditions in the mountains and confined conditions at the valley margins (Avery, 1994).

Permeability values for the Norwood Tuff, Paleozoic carbonates, Cambrian clastic rocks, and Precambrian metasediments are very low to low (Avery, 1994). Most bedrock wells are drilled into the low- to moderate-permeability Wasatch Formation (Avery, 1994). A few springs are found at the valley margins, originating in the Norwood, Wasatch, and Paleozoic carbonate formations (Avery, 1994). These springs provide some of the municipal water supply for Ogden Valley communities.

Recharge and Discharge

Ground water in bedrock begins as precipitation falling on the highlands surrounding Ogden Valley. Most mountain precipitation in the area falls as snow, and infiltration of the annual melt is the source of most of the recharge to bedrock aquifers. Seepage from streams provides some additional recharge.

Once in bedrock aquifers, water percolates downward and toward the center of the valley. Some water is discharged back to mountain streams. Some bedrock springs along the mountain fronts discharge water to the surface. Water also discharges locally to the unconsolidated aquifers along the valley margins. The fine-grained, low-permeability Norwood Tuff underlies the valley fill in many areas, reducing the hydrologic connection between the base of valley fill and older bedrock units in many areas of the valley (Lowe and Miner, 1990; Avery, 1994).

Water Quality

Water from bedrock springs in Ogden Valley is of a very high quality. Monastery Spring, a drinking-water source for Huntsville, discharges from carbonate rocks 3 miles (4.8 km) southeast of the town. Total-dissolved-solids concentrations for the spring average 197 mg/L, and nitrate concentrations average 0.52 mg/L (Utah Division of Drinking Water, 1995). Burnett Spring, a high-quality water source for Eden, discharges from the Norwood Tuff 2 miles (3.2 km) north of the town. Total-dissolved-solids concentrations average 66 mg/L, and nitrate concentrations are 0.34 mg/L (Utah Division of Drinking Water, 1995). These springs are typical of bedrock water sources in Ogden Valley.

Unconsolidated Valley-Fill Aquifer

The principal unconsolidated valley-fill aquifer in Ogden Valley is Pleistocene-age fluvial gravel, sand, and silt (Lofgren, 1955). This aquifer is confined by pre-Lake Bonneville silt in the center of the valley, but extends away from the confining layer to the north and east where it is under water-table conditions. The principal valley-fill aquifer is the most important source of water for wells in Ogden Valley.

Aquifer Characteristics

The principal valley-fill aquifer in the center of the valley beneath Pineview Reservoir has artesian pressure and provides water to Ogden City. The aquifer is confined by a lacustrine silt layer. The transmissivity of this important aquifer is estimated at 79,000 square feet per day (7,300 m^2/day) (Avery, 1994).

The silt confining layer covers 10 square miles (26 km^2) and has vertical hydraulic conductivity values between 0.01 and 0.04 foot per day (.003 to.012 m/day), indicating that it is a leaky confining layer (Avery, 1994). The principal aquifer discharges to stream channels that cut as deep as 25 feet (7.5 m) into the confining layer (Avery, 1994). Leggette and Taylor (1937) identified springs along the channels which are evidence of this discharge, although Pineview Reservoir has since inundated the area. Avery (1994) reports seepage values during July 1986 ranging from 0.17 to 0.20 feet per day (0.052 to 0.061 m/day), indicating that upward leakage continues into Pineview Reservoir. Water levels in wells are generally below the surface of Pineview Reservoir, indicating that some downward leakage from the reservoir to the principal aquifer may also occur (Avery, 1994). Avery (1994) believes that leakage through the confining layer controls water levels in the principal aquifer.

The confining layer, where present, is capped by a shallow, unconfined aquifer consisting primarily of 10 to 60 feet (3-18 m) of transgressive Lake Bonneville silt and sand and, to a lesser extent, post-Lake Bonneville fluvial sand and gravel (Lowe and Miner, 1990). This shallow aquifer is relatively unproductive and few wells tap it.

In the valley beyond the confining layer, the principal valley-fill aquifer is under water-table conditions but contains a few small perched aquifers. The unconfined aquifer consists primarily of pre- and post-Lake Bonneville fluvial and alluvial-fan sediments. Fifty percent of the wells drilled in this area are in the depth range of 50 to 100 feet (15-30 m) (Lowe and Miner, 1990).

Recharge and Discharge

In general, ground water flows from the mountains toward Pineview Reservoir. Ground-water gradients in the northern part of the valley are around 80 feet per mile (15 m/km), decreasing toward Pineview Reservoir to 15 feet per mile (2.8 m/km) (Avery, 1994). Ground water in the unconfined part of the principal aquifer in the northern and eastern parts of the valley flows through the valley fill toward Pineview Reservoir. At the confining layer, ground water splits and either flows above the layer into the shallow unconfined aquifer and on into Pineview Reservoir or below the layer into the confined aquifer (Leggette and Taylor, 1937; Lowe and Miner, 1990) (figure 2). Ground water exits the valley through Ogden Canyon.

Much of the annual recharge takes place during the spring due to seepage from streams and direct infiltration of mountain snowmelt (Avery, 1994). Some additional recharge is from seepage from irrigation ditches and lateral inflow from bedrock surrounding the valley (Avery, 1994). Ground water is discharged through wells, marshes, and the many valley springs.

The unconfined part of the principal aquifer is a primary recharge area. Some clay lenses create shallow perched aquifers, particularly in the northern part of the study area, but these areas are small and isolated.

The approximate areal extent of the confining bed of the principal aquifer was first mapped by Leggette and Taylor (1937). Using well data, we have delineated areas where the silt and clay layer is thicker than 20 feet (6 m). The entire confining layer is considered to be the secondary recharge area in Ogden Valley. Pineview Reservoir covers most of the confining layer. The principal valley-fill aquifer leaks upward to the reservoir (Avery, 1994), and some wells flowed to the surface before the reservoir inundated them (Leggette and Taylor, 1937), but these regions are now under water and are not mapped discharge areas. The artesian head in the confined part of the principal aquifer is generally below the level of the reservoir, although there are some flowing wells near Huntsville. These discharging wells, and other areas where the artesian head in the principal aquifer is above the level of the reservoir or shallow water table, are too localized and variable (depending on reservoir level) to map as a discharge area. The pumped wells of the Ogden City well field are located on the southern tip of the peninsula in Pineview Reservoir between the North and Middle Forks, 1 mile (1.6 km) south of Eden. Heavy withdrawals in this area may increase recharge from the reservoir to the confined part of the principal aquifer (Avery, 1994). Discharge occurs from the confined part of the principal aquifer to Pineview Reservoir, but discharge areas under water are not shown on the map. In addition, there are some flowing wells within the area of the confined aquifer, but these wells are sporadically distributed so the entire confined area is mapped as a secondary recharge area.

The South Fork of the Ogden River becomes a losing stream when it flows into the valley, crosses the fault bounding the eastern side of the valley, and recharges the unconfined principal aquifer along a 2-mile stretch where the river is dry much of the year (Lowe and Miner, 1990). When the stream flows over the confining layer, water is forced back to the surface as springs (Lowe and Miner, 1990). Leggette and Taylor (1937) proposed that when the confined part of the principal aquifer is full, water is forced above the confining bed and back into the streams and the shallow unconfined aquifer, whereas when the aquifer has been depleted by discharge to wells, water from the streams recharges the confined aquifer.

Discharge from the principal aquifer is by: (1) seepage to streams, springs, and Pineview Reservoir; (2) wells; and (3) evapotranspiration. There is no evidence that ground water exits the valley below Pineview Dam (Avery, 1994).

Water Quality

Ground water in Ogden Valley is generally a calcium-bicarbonate type with fewer than 350 mg/L total dissolved solids (Avery, 1994). This is within the range of class IA, the highest quality water. In general, the North Fork Ogden River has slightly lower total-dissolved-solids concentrations than the Middle Fork Ogden River and the South Fork Ogden River (Avery, 1994).

The monthly average coliform bacteria levels in the South Fork Ogden River have increased approximately 600 percent between 1974 and 1985 (Weber Basin Water Quality, 1986). Lowe and Miner (1990) propose that this increase can be attributed to increased recreational use of the Cache National Forest in the drainage. Since South Fork water directly recharges the ground water east of Huntsville, this could pose a future problem. Avery (1994) identified one well, (A-6-2) 6dad-1, with 11 mg/L nitrate, which exceeds EPA and DWQ drinking-water standards for nitrate. Monthly average nitrate concentrations in the shallow unconfined aquifer are slightly higher than levels in surface streams (Lowe and Miner, 1990).

Water in the principal aquifer remains of high quality, primarily for two reasons: (1) the large quantity of good-quality ground water that recharges the aquifer annually, and (2) the relatively low population density in the valley (Lowe and Miner, 1990). Development is increasing however, and most of this development depends on septic-tank soil-absorption systems for waste-water disposal. Increased development without consideration of siting of contaminant sources in primary recharge areas may jeopardize the high quality of ground water in Ogden Valley. The geology and small population of the valley at present are maintaining a high-quality drinking water supply, but there are some signs of increasing nitrate and coliform contamination. Careful monitoring of water quality should continue in the future.

SUMMARY AND CONCLUSIONS

The principal valley-fill aquifer in Ogden Valley consists of Pleistocene fluvial, lacustrine, and alluvial-fan gravel deposits, and is confined under Pineview Reservoir by pre-Lake Bonneville lacustrine silt. The confined aquifer is the most important source of ground water in Ogden Valley. It also provides water to Ogden City. In the valley beyond the outer margins of the confining layer, the principal aquifer is under water-table conditions.

Ground-water flow is from the mountains toward Pineview Reservoir, and most recharge comes from infiltration of surface water during the spring snowmelt. The primary recharge area is the surrounding mountains, and the valley floor beyond the margins of the confining layer. The region above the confining layer, around

Pineview Reservoir, is a secondary recharge area. No discharge areas have been mapped. Discharge is by seepage to surface water, wells, and evapotranspiration. Water quality is high, although the possibility exists for future contamination as land use becomes more intensive in primary recharge areas.

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Appendix

Records of Wells, Ogden Valley, Utah

Site number: See plate 1 for well location. Only wells used to define recharge and discharge areas plotted.

Local well number: See text for explanation of numbering system.

Elevation: In feet above sea level.

Well depth: In feet below land surface.

Recharge area: Y, primary recharge area; 1, secondary recharge area; N, discharge area; 2, well completed in shallow unconfined aquifer.

Water level: In feet below land surface, or feet above land surface for "+" values; +F, flowing well.

Top of confining layer: Depth to first confining layer, in feet below land surface.

Bottom of confining layer: Depth to bottom of first confining layer, in feet below land surface.

Depth to bedrock: In feet below land surface; N, bedrock not encountered.

Top of perforations: Depth to top of perforations, in feet below land surface.

Bottom of perforations: Depth to bottom of all perforations, in feet below land surface; MI, multiple perforated intervals, below bottom of uppermost perforated interval.

--, no data

Site number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations	Bottom of perforations	Notes
2	(A-6-1) 1aac-1	1991	4921	150	Y	18	09-09-91	--	--	N	45	195 MI	
3	(A-6-1) 1aba-1	1991	4922	101	Y	19	10-04-91	--	--	N	--	--	
4	(A-6-1) 1abc-1	1982	4921	172	1	22	08-05-82	16	50	N	--	--	
5	(A-6-1) 1baa-1	1977	4921	126	1	30	10-03-77	40	100	N	100	126	
6	(A-6-1) 1bba-1	1968	4918	105	1	17	04-19-68	35	101	N	--	--	
8	(A-6-1) 1dad-1	1975	4933	100	Y	35	--	--	--	N	95	100	
9	(A-6-1) 3bab-1	1961	5040	75	Y	0	07-05-61	--	--	N	13	53	USFS
10	(A-6-1) 3dbb-1	1982	4965	189	1	70	09-24-82	27	107	177	140	189	
11	(A-6-1) 3dbc-1	1967	4960	187	Y	28	06-20-67	--	--	130	140	170	
12	(A-6-1) 3dbc-2	1963	4975	120	Y	47	04-20-63	--	--	N	--	--	
34	(A-6-1) 13cdc-1	1942	4940	52	Y	--	--	--	--	N	--	--	
35	(A-6-1) 13dcc-1	1961	4921	133	Y	26	07-01-61	--	--	N?	110	133	USFS
36	(A-6-1) 14cba-1	1981	5055	260	1	56	05-21-81	58	135	255	80	260	
39	(A-6-1) 23bab-1	1976	5075	351	Y	180	06-30-76	--	--	212	190	350	
44	(A-6-1) 24aba-1	1969	4930	197	1	29	07-17-69	10	38	N	130	150	
54	(A-6-2) 6cab-1	1989	4955	102	N	22	11-30-89	38	60	N	100	102	
55	(A-6-2) 6cba-1	1989	4935	126	Y	28	07-10-89	--	--	N	118	125	
56	(A-6-2) 6cbb-1	1959	4940	86	Y	34	09-01-59	--	--	N	--	--	
57	(A-6-2) 6cbb-2	1979	4945	103	N	25	07-11-79	55	87	N	100	103	
58	(A-6-2) 6cca-1	1976	4915	110	1	20	08-05-76	10	34	103?	--	--	
62	(A-6-2) 6dbb-1	1994	4965	140	Y	38	08-12-94	--	--	N	130	137	
63	(A-6-2) 6dcc-1	1963	4945	57	Y	40	08-31-63	--	--	N	--	--	
71	(A-6-2) 7aac-1	1964	4950	72	1	18	06-01-64	2	26	N	--	--	
73	(A-6-2) 7aba-2	1995	4945	110	Y	14	05-07-95	--	--	N	98	105	
74	(A-6-2) 7abb-1	1990	4935	142	Y	22	05-24-90	--	--	N	131	140	
75	(A-6-2) 7bbb-1	1957	4924	111	Y	45	12-30-57	--	--	N	85	105	
76	(A-6-2) 7bbb-2	1959	4920	88	Y	24	04-24-59	--	--	N	--	--	
78	(A-6-2) 7bbd-1	1980	4925	130	Y	23	10-09-80	--	--	N	105	125	
79	(A-6-2) 7bcc-1	1965	4922	102	1	18	10-26-65	2	34	N	--	--	
80	(A-6-2) 7cac-1	1993	4935	130	Y	35	12-02-93	--	--	N	125	129	
81	(A-6-2) 7cda-1	1979	4915	102	1	18	08-10-79	38	60	N	100	102	

Site number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations	Bottom of perforations	Notes
82	(A-6-2) 7daa-1	1994	4935	221	I	8	07-17-94	0	22	N	83	219 MI	
83	(A-6-2) 7dab-1	1986	4930	131	I	4	08-01-86	2	35	N	110	131	
85	(A-6-2) 7dac-1	1971	4930	123	N	7	08-31-71	30	50	N	--	--	
88	(A-6-2) 7dbd-1	1968	4935	84	Y	39	06-28-68	--	--	N	74	84	
91	(A-6-2) 8bcd-1	1989	4945	24	--	--	--	--	--	N	4	24	
92	(A-6-2) 8cad-1	1989	4950	14	--	--	--	--	--	N	4	14	
99	(A-6-2) 17bac-1	1987	4940	193	Y	12	08-08-87	--	--	N	70	93	
100	(A-6-2) 17bbd-1	1962	4935	41	Y	+1.5	05-11-62	--	--	N	--	--	
102	(A-6-2) 17cbd-1	1968	4950	88	Y	9	09-06-68	--	--	N	--	--	
103	(A-6-2) 17cca-1	1970	4940	124	Y	37	--	--	--	N	86	94	
104	(A-6-2) 17cdb-1	1978	4945	107	N	8	07-31-78	52	85	N	85	107	
114	(A-6-2) 18aab-1	1968	4915	110	N	1	08-02-68	15	40	N	87	97	
120	(A-6-2) 19aac-1	1962	4915	85	I	49	05-25-62	3	75	N	--	--	
122	(A-6-2) 19aca-1	1967	4920	85	N	+10	09-10-67	20	48	N	82	85	
123	(A-6-2) 19bbd-1	1994	4920	120	Y	42	09-02-94	--	--	111	110	119	
124	(A-6-2) 19bbd-2	1993	4920	128	Y	44	09-29-93	--	--	N	--	--	
125	(A-6-2) 19bda-1	1976	4960	200	I	45	07-00-76	30	130	N	--	--	
127	(A-6-2) 19bdb-1	1961	4960	90	I	50	09-01-61	2	42	N	--	--	
132	(A-6-2) 20bac-1	1995	4940	101	N	6	03-18-95	17	42	N	93	100	
136	(A-6-2) 20bca-1	1994	4935	133	N	+F	04-18-94	15	76	N	128	132	
251	(A-7-1) 34adb-1	1982	4955	144	N	20	07-10-82	55	130	N	135	144	
252	(A-7-1) 34bba-1	1949	4975	75	Y	35	07-00-49	--	--	N	65	75	
253	(A-7-1) 34dba-1	1965	4920	118	Y	15	03-10-65	--	--	N	100	117	
255	(A-7-1) 34ddd-1	1987	4925	127	N	40	06-00-87	78	103	N	107	124 MI	
257	(A-7-1) 35bbb-1	1981	4970	160	Y	10	11-17-81	--	--	55?	100	160	
258	(A-7-1) 35bdc-1	1989	4950	101	Y	27	06-21-89	--	--	N	52	97	
260	(A-7-1) 36dbc-1	1975	4920	117	Y	70	12-00-75	--	--	36?	95	117	